GTE Government Systems

NASA - SCAR

Scenarios and Performance Measures

for

Advanced ISDN Satellite Design and Experiments

28 February 1992

(NASA-CR-187329) SCENARIOS AND PERFORMANCE MEASURES FOR ADVANCED ISDN SATELLITE DESIGN AND EXPERIMENTS Update Report (Contel Federal Systems) 45 p CSCL 22B

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Update Report

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SECTION 1
INTRODUCTION

1.1 Background. The objectives of this element of the NASA Satellite Communications Applications Research (SCAR) Program are to develop new advanced on-board satellite capabilities that will enable the provision of new services, namely interim and full Integrated Services Digital Network (ISDN) services via satellite and to provide a system analysis of futuristic satellite communications concepts, namely broadband services via satellite.

This aspect of the NASA SCAR Program provides a research and development effort to:

1) develop basic technologies and concepts to use the on-board processing and switching capabilities of advanced satellites that will permit the provision of interim and full ISDN services and

2) provide a systems and requirements analysis of future satellite communications concepts via a new generation of broadband switching and processing satellites.

These objectives will be achieve in part via modeling and simulation of ISDN satellites as part of the ISDN terrestrial network. Models of the Interim Service ISDN Satellite (ISIS) and the Full Service ISDN Satellite (FSIS) will exercised using discrete event simulation techniques.

To provide meaningful results credible scenarios must be used as simulation inputs and realistic performance measures must be correlatable to the advanced ISDN communications satellite design parameters. Such scenarios will use the traffic model of ISDN users to exercise the network models fully. Performance measures will be evaluated under benign and stressed conditions with scenarios that reflect real world diversities. Such scenarios must contain information about events that occur both inside and outside the network. Examples of network events include network facility failures and surges in service demand. High error rates caused by satellite link degradation due to poor weather is an example of an extra-network event.

An end-to-end network view must be developed using the framework of the CCITT and ANSI standards to establish ISDN performance measures. Network performance measures must assess the overall network in terms of speed, capacity, accuracy, access reliability, and availability. Component performance measurements must provide insight into the engineering performance of the system. The factors of performance measures must include propagation delay, signal degradation, message queue lengths, network node switching delay and raw throughput.

1.2 Scope. This update report documents the views of the scenario generation process and the performance measurement methodology. The process and methodology must be applicable to the ISIS and the FSIS systems as described in Figure 1.1, "NASA/SCAR Approaches for Advanced ISDN Satellites". The ISIS represents satellite systems like the Advanced Communications Technology Satellite (ACTS), orbiting switch. ACTS will be controlled by a ground based master control center (MCC), shown in Figure 1.2, "Closed User-Oriented Scenario". A user of the ACTS satellite switch must request services from the MCC, a combination of the NASA Ground Station (NGS) the Master Control Station (MCS). The MCC in turn commands the satellite to switch the appropriate channel.

The ultimate aim of this element of the SCAR Program is to move these MCC functions on-board the next generation ISDN communications satellite as shown in Figure 1.3, "Advanced ISDN Satellite". The technical and operational parameters for the advanced communications satellite design will be obtained from an engineering software model of the major subsystems of the ISDN communications satellite architecture. Discrete event simulation experiments will be performed with the model using various traffic scenarios, design parameters, and operational procedures. The data from these simulations will be analyzed using the performance measures discussed in this report.

1.3 Document Overview. This update report begins by describing the use of modeling and simulation to determine the design parameters for the SCAR advanced ISDN communications satellite design. An overview of the modeling and simulation tasks includes a brief description of the four software programs of that effort. Particular associations are made between the the Scenario Generation Program and the Scenarios described in this report , and the Product Generation Program and the Performance Measures also identified herein. The two main sections of this update report are Scenario Generation and Performance Measures.

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ISIS Interim Service ISDN Satellite	FSIS Full Service ISDN Satellite	BSIS Broadband Service ISDN Satellite
• ACTS-like Satellite Design and Transponder	• New ISDN Satellite Design with onboard Class 5 Switch and SS7 Network Interface	• Advanced ISDN Satellite Design with onboard Class 5 Switch and SS7 Network Interface and layered protocol
• Provide Narrowband ISDN Services (Basic Rate Access)	• Provide Narrowband ISDN Services (Basic/Primary Rate Access)	• Provide Broadband ISDN Services (Primary Rate Access)
• Provide remote access ISDN Satellite Terminals using ISDN Satellite Terminal Adapter	• Provide nationwide single hop single CONUS earth coverage antenna satellite link connectivity to an interexchange node for ISDN Satellite Terminals (up to 10,000 ISAT)	• Provide nationwide single hop, multiple high gain hopping beams, forward error control, optical processing, and "zero delay" satellite link interexchange node connectivity
• Will use D channel signaling but NOT SS7	• Will use D channel signaling with SS7	• Will use D channel signaling with SS7
• Will use ACTS call control and Baseband Switching Architecture	• Will use SS7 call control with minimum call set-up time and efficient satellite BW utilization	• Will center design around ATM fast packet switching techniques

Figure 1.1 NASA/SCAR Approaches for Advanced ISDN Satellites

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Approach Adv ISDN Satel
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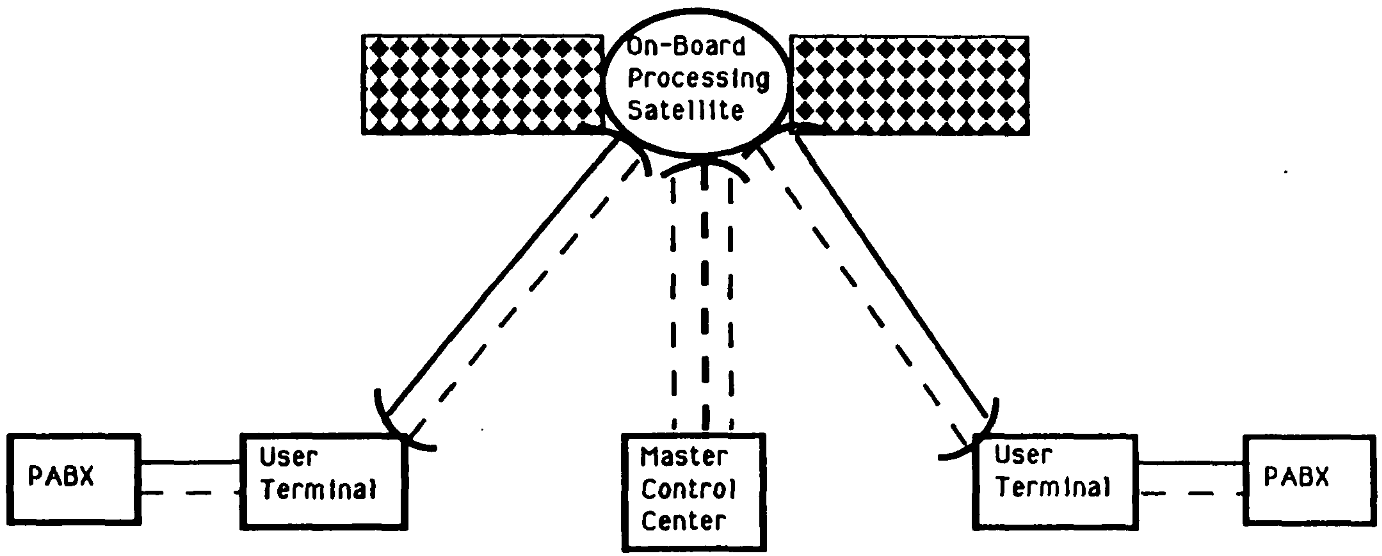

Figure 1.2 Closed User-Oriented Scenario

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Satel/MCC Figure
August 21, 1991

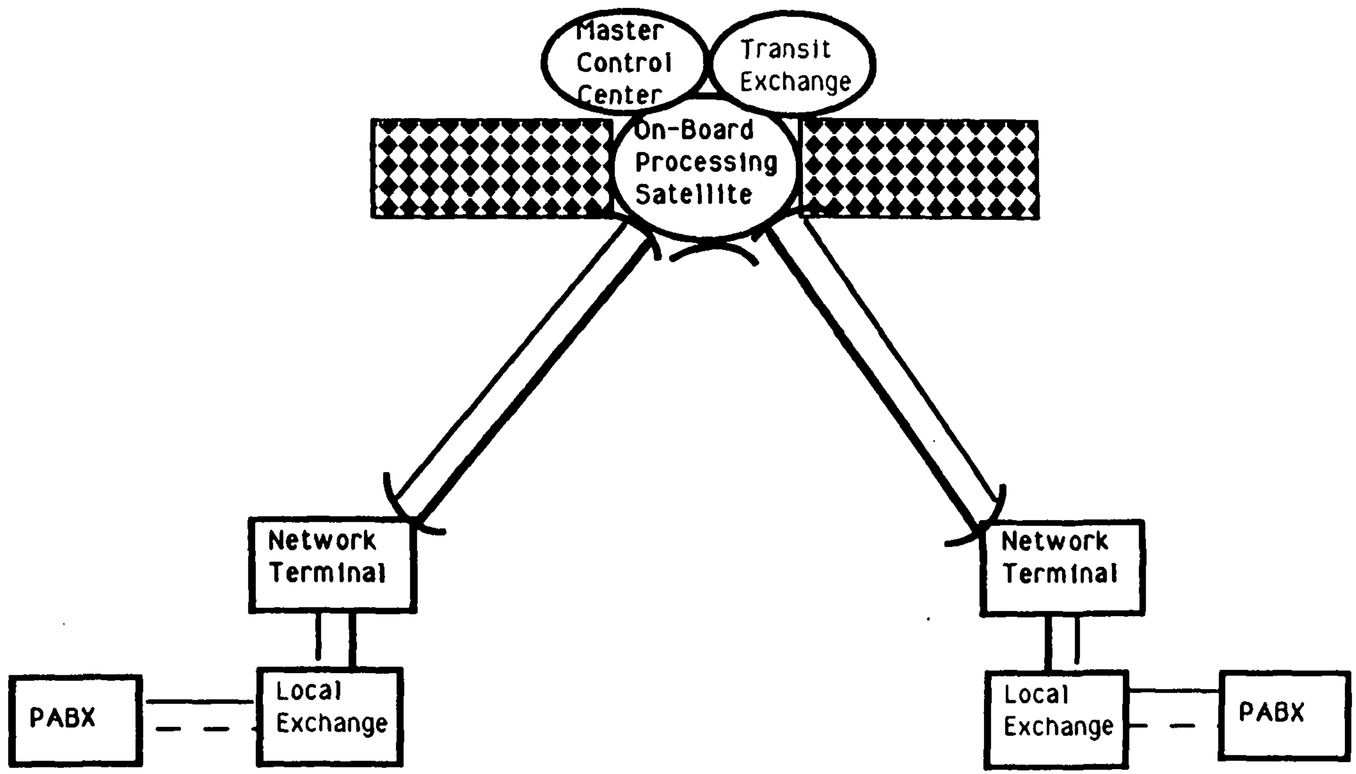

Figure 1.3 Advanced ISDN Satellite

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Adv ISDN Satel
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The Scenario Generation Section describes the Scenario Generation Program and its association with the Traffic Model Database. After a brief description of the database elements, they are used in a scenario generation example to demonstrate their flexibility and utility in providing Scenario Traffic Files (STFs). Four types Scenario Scripts are defined: checkout, baseline, stress, and special scenarios. Each is described in detail together with their application to the SCAR advanced ISDN communications satellite design process.

The Performance Measures Section introduces the concepts, definitions and purposes of measurements as tools for evaluating the evolving ISDN communications satellite design. Four performance measure categories are identified: throughput, response time, blocking probability, and robustness. Each is presented in terms of their major factors, their application levels, and their measurement parameters as associated with this NASA SCAR effort. A summary matrix is developed associating the performance measures with the major communication subsystems, and modeling and simulation modules.

SECTION 2
MODELING AND SIMULATION

2.1 Modeling and Simulation Objective. The objective of this modeling and simulation project is to design and develop software models that can be used to simulate those aspects of the ISDN communications satellite with sufficient fidelity to assist in its design. This end-to-end simulation will include sufficient functionality to demonstrate the interactions between each of the four modeling and simulation phases: database generation program, scenario generation program, simulation run program, and product generation program. A description of each of these programs has been abbreviated in order to focus on the the scenario generation and performance measures.

2.2 Major Modeling and Simulation Tasks. The major modeling and simulation tasks for this SCAR Project are depicted in Figure 2.1, "Task Flow Diagram for the SCAR Program". Each of these tasks is described in the following sections in order to provide an overview of the modeling and simulation process as well as to provide context for the scenarios and performance measures:

2.2.1 Database Generation Program. The Database Generation (DbGen) program assembles the major ISDN user characteristics into a machine readable database. For this NASA SCAR effort that database consists of the traffic model database of ISDN user characteristics. That database is an input to the scenario generation process. A brief description of this traffic model database is presented in Section 3.2.

2.2.2 Scenario Generation Program. The Scenario Generation (ScenGen) program selects entries from the user traffic model database and engineering parameter databases to generates a list of time ordered, initiating discrete events. The discrete event list is call a Scenario Traffic File (STF). The STF is used to initialize the model for a specific ISDN communications satellite design and to exercise that satellite design using the requests for service dictated by the user traffic. Since this is one of the principal topics of this update report Section 3.0 is dedicated to Scenario Generation.

2.2.3 Simulation Run Program. The Simulation Run (SimRun) program consists of a model of the real world communications network of the major ISDN

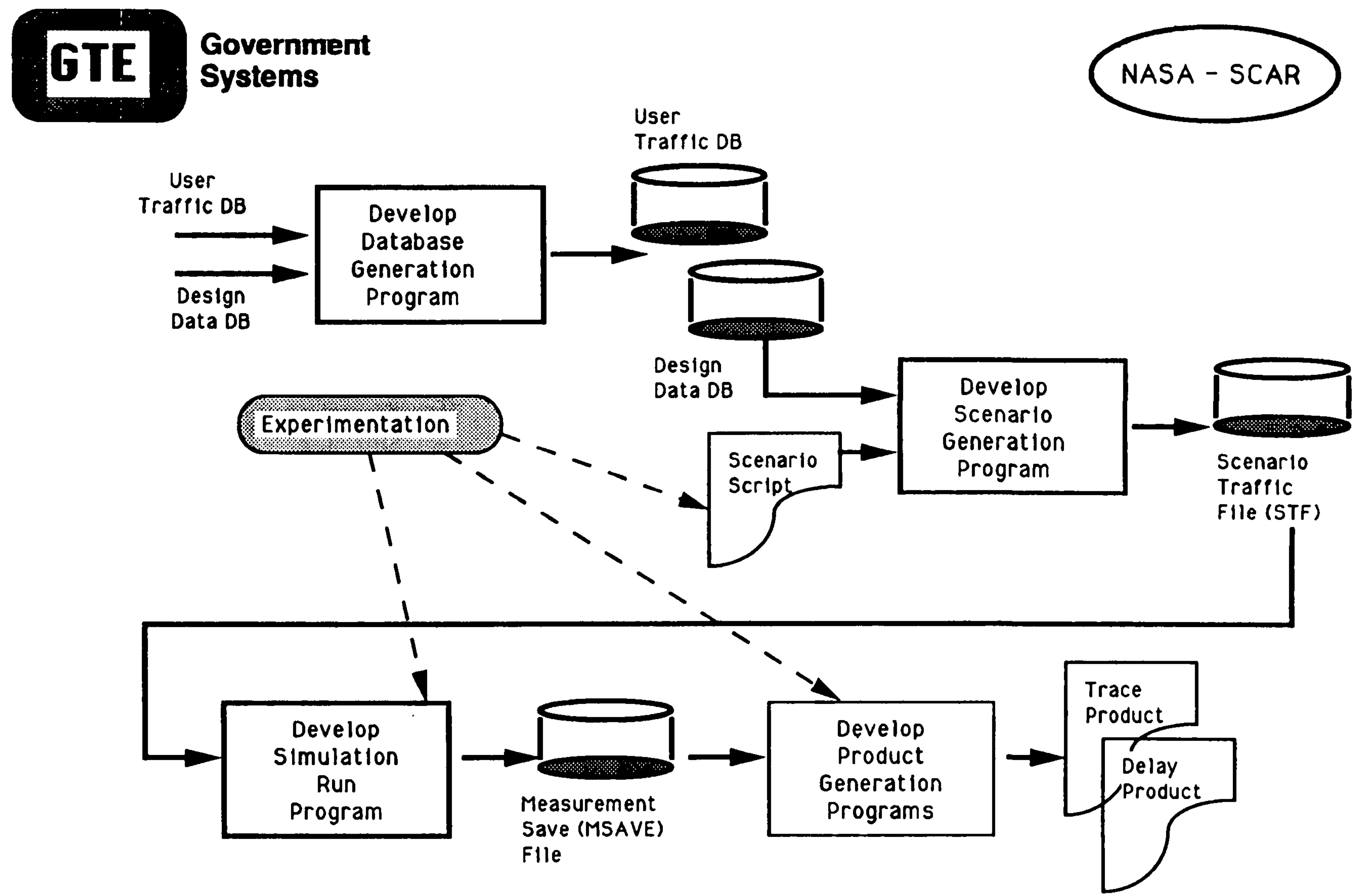

Figure 2.1 Task Flow Diagrams for the NASA SCAR Program

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Build 0 Task Flow
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components. Each of these ISDN communication components is represented by a block diagram within the overall architecture of the complete network.

The SimRun program essentially reads each discrete event from the (STF); takes the appropriate action; and logs that action and the corresponding results in a measurement save (MSAVE) file. The appropriate action taken by the simulation includes allocating and releasing communication resources, denying specific services, and calling other processes in-turn.

2.2.4 Product Generation Program. The Product Generation (ProdGen) program reads the data in the MSAVE file and analyses these data in accordance with specific algorithms. It is envisioned that there will be as many product generation programs as there are issues to be studied: throughput, response time, trace, delay, call blocking, busy-minute, busy-hour, etc. The performance measures cited in this report will be used a criteria to evaluated the design parameters, operational procedures and degree of ISDN communications standard compliance within the products generated by ProdGen.

2.3 Technical Overview. Integrated Services Digital Network (ISDN) is a communications architecture that can use existing telephone lines for digital traffic. ISDN make use of existing connectivity between users and telephone exchanges. Added services are made available by adding new equipment both at the customer end and the telephone office end.

ISDN offers extended user services through the use of digital technology and common channel signaling. Access to the digital transport facilities occurs on 64 kbps bearer (B) channels while access to the signaling network occurs on 16 kbps (BRI-D) or 64 kbps (PRI-D) signaling channels.

Signal System Number 7 (SS7) provides a separate path for signaling services between telephone central offices (COs). In the past trunk lines were used to control the call request from one CO to another - known as "in-band" signaling. The "off-hook", ringing signals, and switch controls used the same lines as the telephone conversations. These trunks used for signaling could not be used for conversations resulting in a loss of revenue.

A number of signaling architectures have evolved. The surviving architectures have used common channel signaling - known as "out-of-band" signaling. Dedicated, less expensive

communication paths have been installed between each CO solely for the purpose of signaling. It is no longer necessary to use more expensive trunk lines for these services.

The advanced ISDN communications satellite design under the NASA SCAR Program uses as its design starting point the Advanced Communications Technology Satellite (ACTS) as a switch in orbit. That ACTS orbiting switch is presently controlled by a ground based master control center (MCC), a combination of the NASA Ground Station (NGS) and the Master Control Station (MCS). A user of the ACTS satellite switch must request services from the MCC. The MCC in turn commands the satellite to switch the appropriate channel.

The ultimate aim of this aspect of this SCAR Program is to move that MCC function on-board the satellite for the next generation communications satellite design. The technical and operational parameters for the advanced communications satellite design will be obtained from an engineering software model of the major subsystems of the communications satellite architecture. Discrete event simulation experiments will be performed with the model using various traffic scenarios, technical parameters, and operational procedures and performance measures.

SECTION 3
SCANARIO GENERATION

3.1 Scenario Generation Program. The ISDN satellite end-to-end simulation is shown in Figure 3.1, "End-to-end Model Architecture". Each program is physically and functionally separated by input/output data files. This separation ensures that each program is independent and that each project phase is separate from the others. The only link between these programs is the data file they share.

3.2 Traffic Model Database. The Scenario Generation (ScenGen) program reads the traffic model database that describes potential ISDN users and the statistical information describing the ISDN services requested. See Figure 3.2, "Scenario Generation Program". This traffic model consists of a number of databases: the City Reference DB, ISDN User vs Industry DB, Application vs Industry DB, Application vs Time DB, and Application vs Bearer Services DB. In order to provide a more meaningful context for the scenario generation process each of the traffic model database and their data elements will be briefly describe:

3.2.1 City Reference Database (SCAR DB1). This database, Table 3.1, "City Reference Database", identifies the percentage of ISDN users that are associated with the population of fifty major cities. The geographic coordinates of these of these cities together with their US time-zone permit their use with communications satellite network. A view of the geographical distribution of these CONUS Cities is shown in Figure 3.3, "Traffic Model CONUS City Location.

3.2.2 ISDN User versus Industry Database (SCAR DB2). This database, Table 3.2, "ISDN User vs Industry", apportions the ISDN traffic among twenty-one industries. These data permit the scenario selection on an industry-by-industry basis.

3.2.3 Application versus Industry Database (SCAR DB3). This database, Table 3.3, "Application vs Industry Database", further apportions the industry into applications of communication services. This added data granularity permits the selection of scenarios tailored on an application basis.

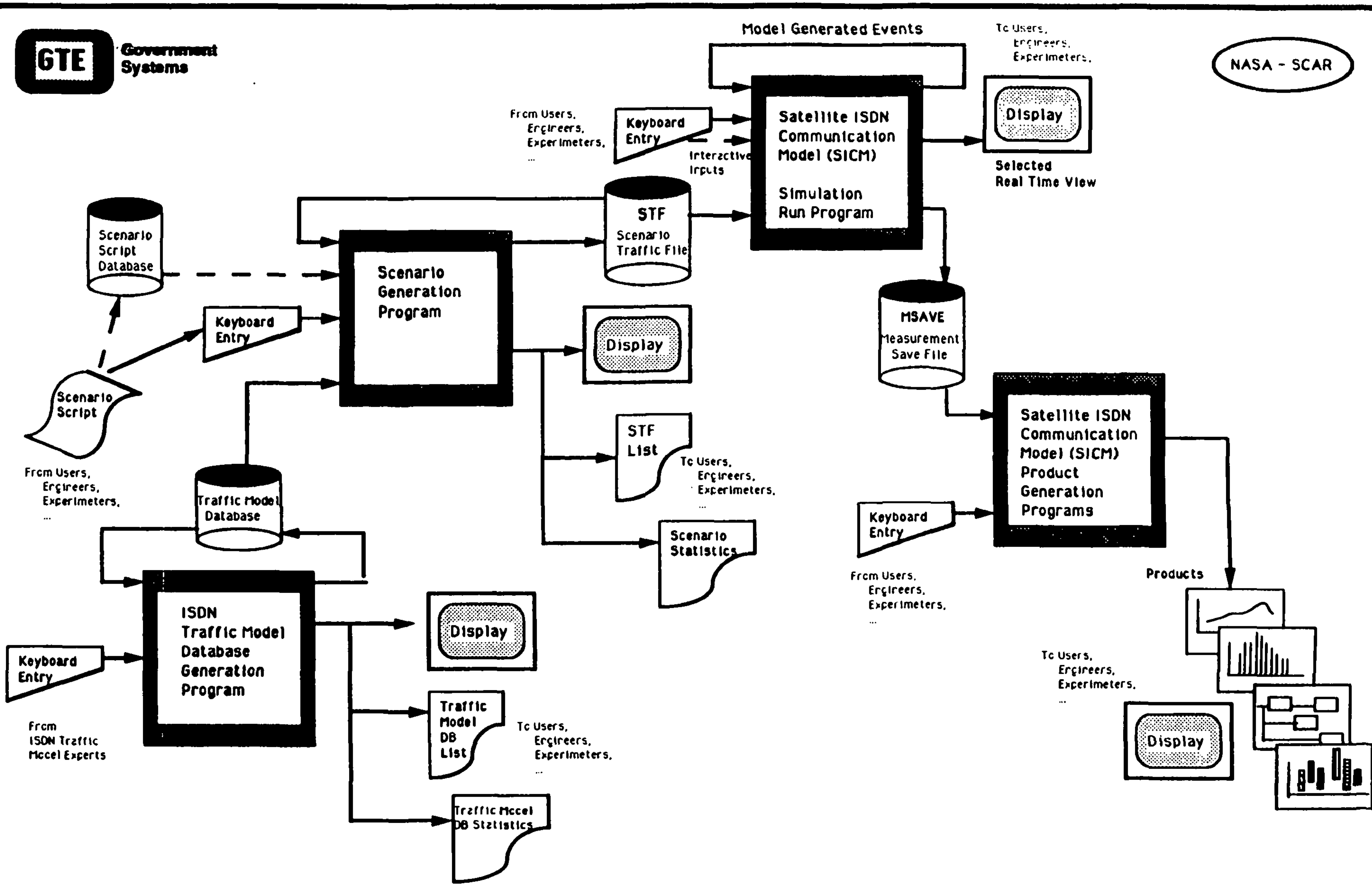

Figure 3.1 End to End ISDN Model Architecture

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End to End ISDN Model Arch
August 21, 1991

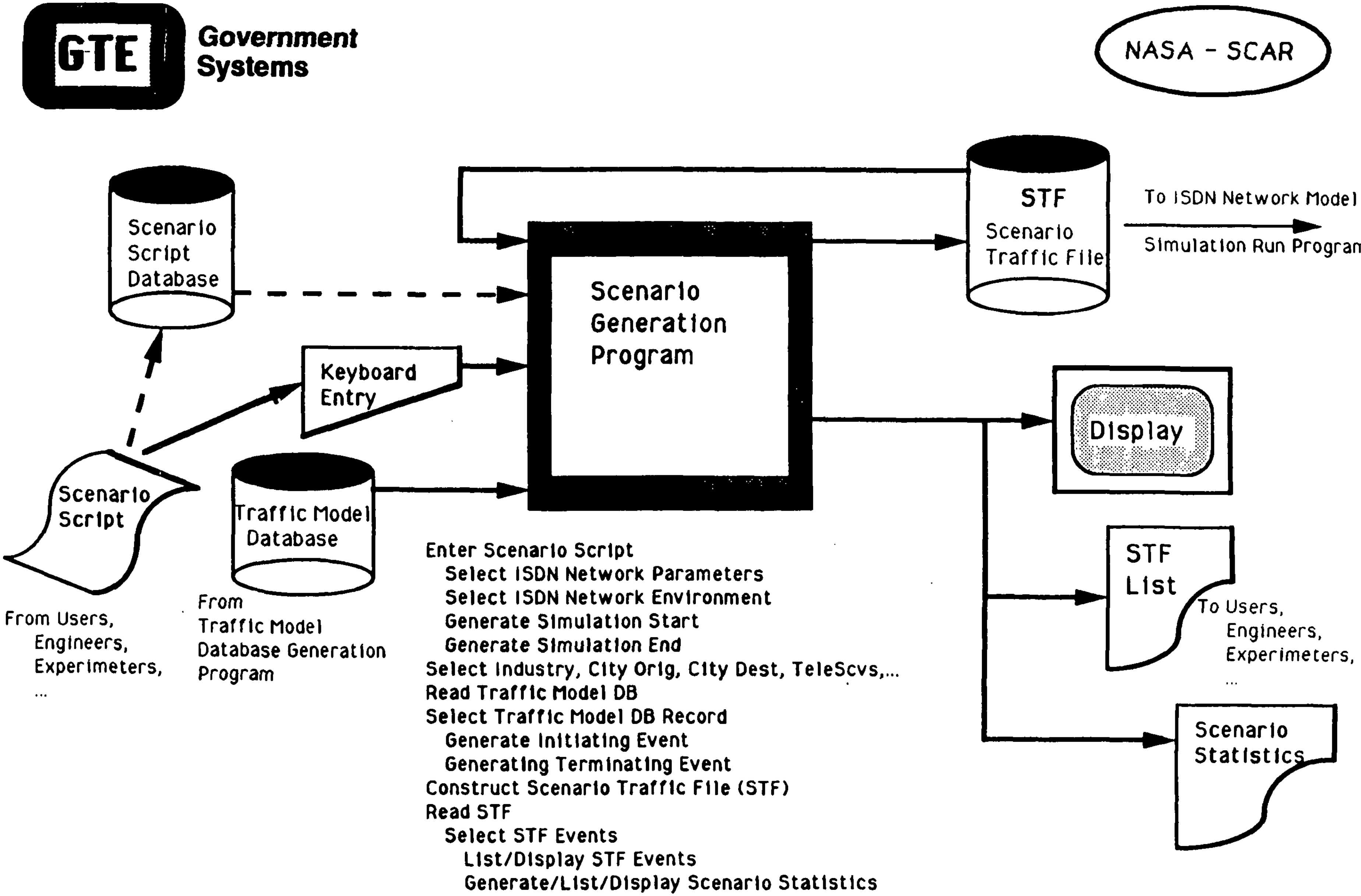

Figure 3.2 Scenario Generation Program

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Scen Gen Top Lvl Diag
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Table 3.1 City Reference Database

SCAR Database 1.

CITYNAME	POPULATION	LATITUDE	LONGITUDE	ISDNPCT	TIMEZONE
	,000	deg	deg	%	#
Honolulu	838	21	-157	3.30	-5
Anchorage	227	61	-150	3.10	-4
Seattle-Tacoma	2,421	47	-122	3.40	-3
Portland-Vancouver	1,414	45	-122	3.10	-3
San Francisco-Oakland-San Jose	6,042	37	-122	4.00	-3
Sacramento	1,385	38	-121	3.30	-3
Los Angeles-Anaheim-Riverside	13,770	34	-118	4.50	-3
San Diego	2,370	32	-117	3.30	-3
Phoenix	2,030	33	-112	3.30	-2
Salt Lake City-Ogden	1,065	40	-111	3.10	-2
Denver-Boulder	1,858	39	-103	3.10	-2
Houston-Galveston	3,641	32	-100	3.40	-1
San Antonio	1,323	30	-98	3.10	-1
Oklahoma City	964	35	-97	3.20	-1
Dallas-Fort Worth	3,766	32	-97	3.40	-1
Kansas City	1,575	39	-94	3.10	-1
Minneapolis-St. Paul	2,388	44	-93	3.30	-1
St. Louis	2,467	38	-90	3.20	-1
Memphis	979	35	-90	3.10	-1
New Orleans	1,307	29	-90	3.10	-1
Milwaukee-Racine	1,572	42	-87	3.10	-1
Chicago-Gary Lake County	8,181	41	-87	3.90	0
Indianapolis	1,237	39	-86	3.10	0
Nashville	972	36	-86	3.10	-1
Birmingham	923	33	-86	3.10	-1
Louisville	967	38	-85	3.10	0
Cincinnati-Hamilton	1,728	39	-84	3.20	0
Dayton-Sprigfield	948	39	-84	3.20	0
Atlanta	2,737	33	-84	3.20	0
Detroit-Ann Arbor	4,620	42	-83	3.30	0
Columbus	1,344	39	-83	3.10	0
Tampa-St. Petersburg-Clearwater	1,995	27	-82	3.20	0
Cleveland-Akron-Lorain	2,769	41	-81	3.30	0
Jacksonville	898	30	-81	3.10	0
Orlando	971	28	-81	3.20	0
Pittsburgh-Beaver Valley	2,284	40	-80	3.20	0
Charlotte-Gastonia-Rocky Hill	1,112	35	-80	3.10	0
Miami-Fort-Lauderdale	3,001	25	-80	3.30	0
Greensboro-Winston-Salem-High	925	36	-79	3.10	0
Buffalo-Niagara Falls	1,176	42	-78	3.20	0
Rochester	980	43	-77	3.20	0
Washington	3,734	38	-77	3.30	0
Richmond-Petersburg	844	37	-77	3.20	0
Baltimore	2,342	39	-76	3.20	0
Philadelphia-Winington-Trenton	5,963	39	-75	3.80	0
Norfolk-Virginia Beach-Newport News	1,380	36	-74	3.20	0
Hartford-New Britain-Middleton	1,068	42	-73	3.00	0
Albany-Schenectady-Troy	851	42	-73	3.20	0
New York-New Jersey-Long Island	18,120	40	-73	5.00	0
Boston-Lawrence-Salem	4,110	42	-71	3.30	0
Providence-Pawtucket-Fall River	1,125	41	-71	3.00	0
San Juan-Caguas-Ponce, PR	550	18	-66	3.20	1
52 Count				5.00 Max	
				3.29 Avg	
				3.00 Min	

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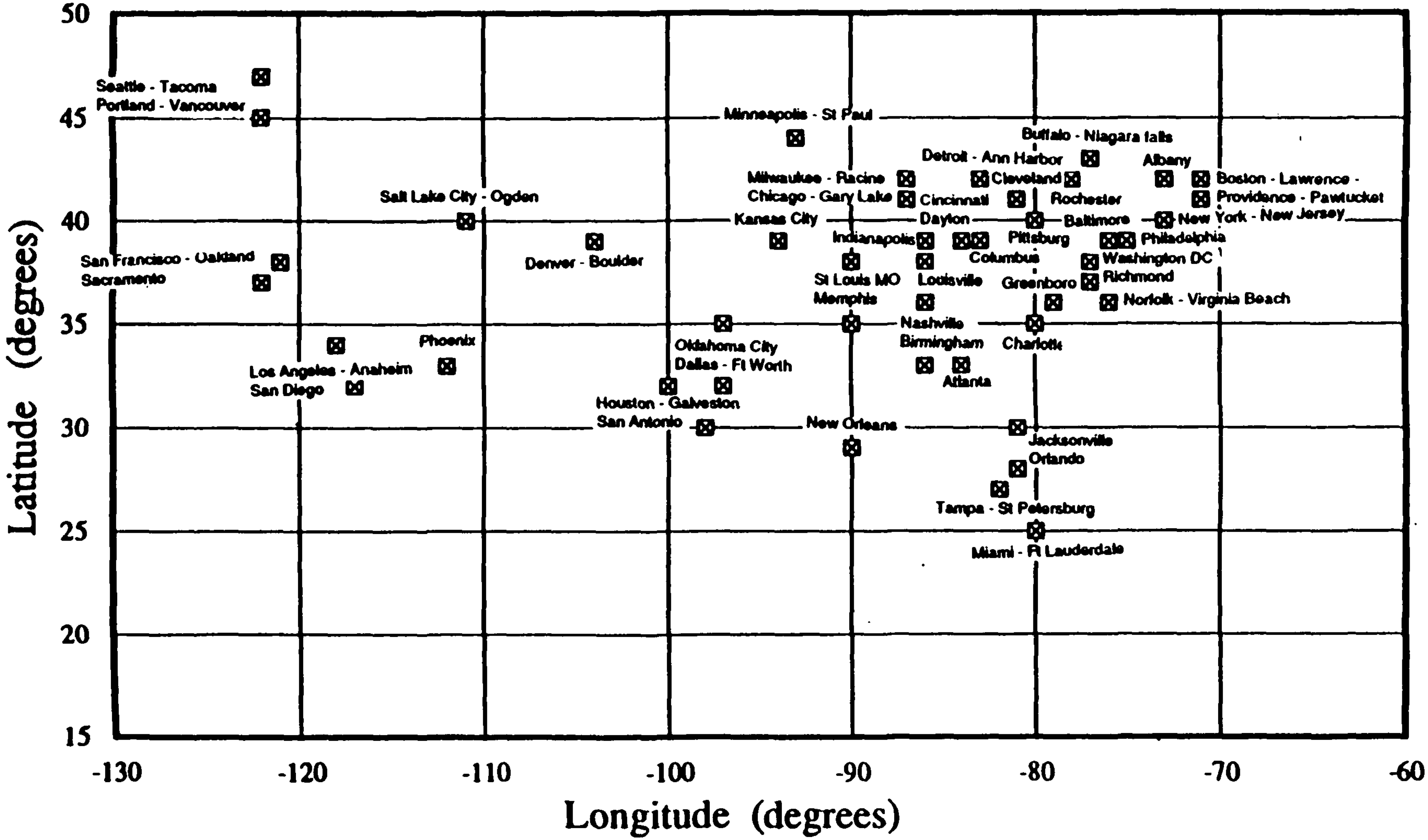

Figure 3.3 Traffic Model CONUS City Locations

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TrafModel City Loc Map
August 23, 1991

Table 3.2 ISDN User vs Industry

SCAR Database 2.

Industry	*ISDN %*
BROADCAST	4.0
COMMUNICATION	10.0
CONSTRUCTION	2.0
DATA PROCESSING	2.0
EDUCATION	6.0
ENERGY	2.0
FINANCIAL	8.0
FOOD SERVVICE	2.0
GOVERNMENT	8.0
LEGAL	6.0
LODGING	4.0
MANUFACTURING	6.0
MEDICAL	6.0
MILITARY	10.0
PUBLISHING	4.0
RECREATION	4.0
RESIDENTIAL	2.0
RETAIL	4.0
TRANSPORT	6.0
UTILITY	2.0
WHOLESALE	2.0
---	-- Check
21 Count	100.0 Normalization

Table 3.3 Application vs Industry Database

SCAR Database 3.

APPLICATION	Total 21 BROADCAST	COMMUNICATION	CONSTRUCTION	DATAPROCESSING	EDUCATION	ENERGY	FINANCIAL	FOODSERVICE	GOVERNMENT	LEGAL	LODGING	MANUFACTURING	MEDICAL	MILITARY	PUBLISHING	RECREATION	RESIDENTIAL	RETAIL	TRANSPORT	UTILITY	WHOLESAL	Check Normalization
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Voice(interactive)	3.0	6.0	3.0	2.0	5.0	3.0	7.0	4.0	4.0	8.0	5.0	5.0	5.0	5.0	5.0	3.0	6.0	5.0	8.0	2.0	6.0	100.0
Voice(message)	0.5	5.0	2.5	1.0	5.0	3.0	10.0	2.5	7.5	10.0	5.0	5.0	5.0	3.0	5.0	2.5	10.0	5.0	5.0	2.5	5.0	100.0
Facsimile	1.0	10.0	5.0	1.0	5.0	2.5	11.0	5.0	11.5	11.0	0.5	5.0	7.0	4.0	10.0	0.5	1.5	1.0	2.5	2.5	2.5	100.0
FileTransfer	0.5	11.0	2.5	11.0	5.0	5.0	9.0	2.5	9.0	5.0	2.5	2.5	3.0	9.0	7.0	1.0	1.0	3.0	4.5	3.0	3.0	100.0
VideoBroadcasting	10.0	8.0	0.5	5.0	8.0	1.0	3.0	1.0	9.0	1.0	6.0	3.0	8.0	10.0	11.0	3.0	3.0	1.0	5.0	1.0	2.5	100.0
VideoConference	6.0	12.0	1.0	1.0	10.0	3.0	10.0	1.0	10.0	7.0	4.0	4.0	6.0	10.0	7.0	1.0	1.0	1.0	3.0	1.0	1.0	100.0
InteractiveData	2.0	15.0	1.0	10.0	10.0	3.0	10.0	2.0	8.0	5.0	1.0	5.0	3.0	10.0	5.0	1.0	3.0	2.0	1.0	1.0	2.0	100.0
Transaction	2.0	8.0	1.0	4.0	2.0	2.0	15.0	2.0	12.0	4.0	5.0	4.0	2.0	8.0	4.0	4.0	1.0	9.0	4.0	1.0	6.0	100.0
Teletex	3.0	10.0	1.0	3.0	3.0	3.0	15.0	3.0	7.0	3.0	5.0	3.0	3.0	7.0	8.0	1.0	1.0	5.0	5.0	1.0	10.0	100.0
Communications Check Sum:	28.0	85.0	17.5	38.0	53.0	25.5	90.0	23.0	78.0	54.0	34.0	36.5	42.0	66.0	62.0	17.0	27.5	32.0	38.0	15.0	38.0	900.0
																						900.0

3.2.4 Application versus Time Database (SCAR DB4). This database, Table 3.4, "Applications vs Time Database", associates daily time-slots for issuing ISDN distributions that are appropriate to the application being used in a scenario.

3.2.5 Application vs Bearer Services Database (SCAR DB5). This database, Table 3.5, "Applications vs ISDN Bearer Service, Message Length Database", associates ISDN bearer services with the selected scenario application. For this SCAR program the following ISDN bearer services have been selected: circuit switched (64 kbps and 128 kbps), D-Channel X.25, B-Channel Frame Relay, and Telemetry. This database also associates the message length and message hold-time with each application.

3.3 Scenario Generation Process: The scenario generation process uses the data from the traffic model database, described in Section 3.2 and generates a scenario traffic file (STF) of initial discrete events for the discrete event simulations described in Section 2.2.3. The STF consists of a time-ordered list of requests for a service and a release of that service when completed. For example, The STF discrete event requesting a circuit-switched B-Channel from Baltimore to Chicago at 0800 am looks like:

Time	CallRef#	Action	Resources	Orig City	Dest City
0800	**1012**	**Rqst**	**CS64**	**Balt**	**Chi**

The corresponding discrete event terminating this call, 31 minutes after its initiation, looks like:

Time	CallRef#	Action
0831	**1012**	**Term**

In the STF discrete event terminating service the unique CallRef# is sufficient to identify that service being terminated.

3.4 Scenario Generation Algorithm. The scenario generation program takes the data from the traffic model database and generates the corresponding STF entries. For example, to generate ISDN calls from Baltimore to Chicago the scenario script must have selected these two cities and possibly other cities. The following algorithm generates the associated ISDN service requests:

Table 3.4 Application vs Time Database

SCAR Darabase 4

APPLICATION	0001-0800 mid/8am 8 hours TIMENO1 %	0801-1200 8am/noon 4 hours TIMENO2 %	1201-1800 noon/6pm 6 hours TIMENO3 %	1801-2400 6pm/mid 6 hours TIMENO4 %	Check Normaization %
Voice(interactive)	2.5	32.0	51.0	14.5	100.0
Voice(message)	2.5	32.0	51.0	14.5	100.0
Facsimile	2.5	32.0	51.0	14.5	100.0
FileTransfer	52.0	3.0	5.0	40.0	100.0
VideoBroadcasting	10.0	25.0	30.0	35.0	100.0
VideoConference	2.5	32.0	51.0	14.5	100.0
InteractiveData	2.5	32.0	51.0	14.5	100.0
Transaction	2.5	32.0	51.0	14.5	100.0
Teletex	2.5	32.0	51.0	14.5	100.0
Communications Check Sum:	79.5	252.0	392.0	176.5	900.0
					900.0

Table 3.5 Application vs ISDN Bearer Service, Message Length Database

SCAR Database 5.

APPLICATION	CS64KBPS	CS128KBPS	DX25	BFRAMERELY	TELEMETRY	Check Normalization	Messsage HOLDTIME	Message Length
	%	%	%	%	%	%	min	kbytes
Voice(interactive)	100.0	0.0	0.0	0.0	0.0	100.0	3.0	0
Voice(message)	100.0	0.0	0.0	0.0	0.0	100.0	1.5	0
Facsimile	80.0	15.0	2.0	3.0	0.0	100.0	0.0	160
FileTransfer	30.0	20.0	30.0	15.0	5.0	100.0	0.0	216
VideoBroad	25.0	40.0	0.0	35.0	0.0	100.0	0.0	9600
VideoConfe	30.0	40.0	0.0	30.0	0.0	100.0	0.0	57600
Interactivedata	20.0	10.0	40.0	10.0	20.0	100.0	0.0	27
Transaction	20.0	20.0	40.0	10.0	10.0	100.0	0.0	27
Teletex	10.0	10.0	40.0	20.0	20.0	100.0	0.0	75
Communications Check Sum:	415.0	155.0	152.0	123.0	55.0	900.0		
						900.0		

1. From SCAR DB1 the population of Baltimore is cited as 2,342,000 with 3.2% of them being daily ISDN users. Therefore, the number of daily ISDN service calls from Baltimore is 74,944.

2. If the scenario script selected, only the following Baltimore industries having the corresponding ISDN percentages in SCAR DB2 then the total daily ISDN service calls from Baltimore by industries would amount to:

	ISDN%	ISDN Calls
Broadcast	4.0%	2,998
Communication	10.0%	7,494
Education	6.0%	4,497

3. If the scenario script further restricted the applications to Voice(Interactive), Voice(Message), and Facsimile, then these Baltimore ISDN service calls are further partitioned by this matrix from SCAR DB3:

	Voice(I)	Voice(M)	Facsimile
Broadcast	3.0%	0.5%	1.0%
Communication	6.0%	5.0%	10.0%
Education	5.0%	5.0%	5.0%

The resulting ISDN service calls from Baltimore in those areas are:

	Voice(I)	Voice(M)	Facsimile
Broadcast	90	15	30
Communication	450	375	750
Education	225	225	225

4. If the scenario script again further restricts the applications to following bearer services: CS64KBPS, CS128KBPS, and DX25 as cited in SCAR DB5, then the following Baltimore ISDN service calls are associated with the ISDN bearer services:

	CS64KBPS	CS128KBPS	DX25
Voice(Interactive)	*100%*	*0%*	*0%*
Broadcast	90	0	0
Communication	450	0	0
Education	225	0	0

	CS64KBPS	CS128KBPS	DX25
Voice(Message)	*100%*	*0%*	*0%*
Broadcast	15	0	0
Communication	375	0	0
Education	225	0	0

	CS64KBPS	CS128KBPS	DX25
Facsimile	*80%*	*15%*	*2%*
Broadcast	24	5	1
Communication	600	113	15
Education	180	34	5

5. These three applications have the same call distribution over time, see SCAR DB4:

Time (hours)	0001-0800	0801-1200	1201-1800	1801-2400
	Time 1	Time 2	Time 3	Time 4
Voice(Interactive)	2.5%	32.0%	51.0%	14.5%
Voice(Message)	2.5%	32.0%	51.0%	14.5%
Facsimile	2.5%	32.0%	51.0%	14.5%

The number of call in each time slots T1/T2/T3/T4 for each Baltimore ISDN service call category is:

	CS64KBPS	CS128KBPS	DX25
Voice(Interactive)	*100%*	*0%*	*0%*
Broadcast	45	0	0
	2/28/46/14	0/0/0/0	0/0/0/0
Communication	450	0	0
	11/144/220/65	0/0/0/0	0/0/0/0
Education	225	0	0
	6/72/114/33	0/0/0/0	0/0/0/0

	CS64KBPS	CS128KBPS	DX25
Voice(Message)	*100%*	*0%*	*0%*
Broadcast	15	0	0
	0/5/8/2	0/0/0/0	0/0/0/0
Communication	375	0	0
	9/120/191/55	0/0/0/0	0/0/0/0
Education	225	0	0
	6/72/114/33	0/0/0/0	0/0/0/0

	CS64KBPS	CS128KBPS	DX25
Facsimile	*80%*	*15%*	*2%*
Broadcast	24	5	1
	1/8/12/3	0/2/3/0	0/0/1/0
Communication	600	112	15
	15/192/306/87	3/36/58/16	0/5/8/2
Education	180	34	5
	4/58/92/26	1/11/17/5	0/2/3/0

Within each of these time-slots the ISDN service calls are assumed to be uniformly distributed. In our example, the 45 ISDN calls from Baltimore that are associated with the broadcast industry that use the CS64KBPS ISDN bearer service fall into a 1/14/23/7 time-slot distribution pattern. This means that :

1 ISDN call will be selected from a uniform distribution between 0001-0800 hrs,
14 ISDN calls will be selected from a uniform distribution between 0801-1200 hrs,
23 ISDN calls will be elected from a uniform distribution between 1201-1800 hrs, and
7 ISDN calls will be selected from a uniform distribution between 1801-2400 hrs.

A sequence number is produced by the ScenGen program to uniquely identify each call. The resulting STF for initiating these 45 ISDN service calls from Baltimore could look:

Time	CallRef		Action	Rersour		OrigCity DestCity
0700	0001	Rqst	CS64	Balt	*	where:
						* = represents a city selected from a uniform distribution of those cities selected by the scenario script.
0815	0002	Rqst	CS64	Balt	*	
0830	0003	Rqst	CS64	Balt	*	
...						
1148	0015	Rqst	CS64	Balt	*	
1215	0016	Rqst	CS64	Balt	*	
1232	0017	Rqst	CS64	Balt	*	
...						
1749	0038	Rqst	CS64	Balt	*	
1816	0039	Rqst	CS64	Balt	*	
1915	0040	Rqst	CS64	Balt	*	
...						
2347	0045	Rqst	CS64	Balt	*	

6. The length of time associated with the use of these ISDN bearer services is proportional to the hold-time for that service. SCAR DB5 cites these hold-

times as a function of the application. For our example of the 45 CS64KBPS messages the hold-time is 3 minutes. Using a uniform distribution with a parametric value of 3, hold-times are determined for each ISDN call. That hold-time is added to the call request event time to determine the call termination event time. The resulting STF is shown below. The unique CallRef# is sufficient to handle the disconnect request.

Time	CallRef	Action	Rersour	OrigCity	DestCity
0700	0001	Rqst	CS64	Balt	*
0702	0001	Term			
0815	0002	Rqst	CS64	Balt	*
0818	0002	Term			
0830	0003	Rqst	CS64	Balt	*
0831	0003	Term			
...					
1148	0015	Rqst	CS64	Balt	*
1201	0015	Term			
1215	0016	Rqst	CS64	Balt	*
1218	0016	Term			
1232	0017	Rqst	CS64	Balt	*
1233	0017	Term			
...					
1749	0038	Rqst	CS64	Balt	*
1750	0038	Term			
1816	0039	Rqst	CS64	Balt	*
1818	0039	Term			
1915	0040	Rqst	CS64	Balt	*
1918	0040	Term			
...					
2347	0045	Rqst	CS64	Balt	*
2349	0045	Term			

where:

* = represents a city selected from a uniform distribution of those cities selected by the scenario script.

This STF suitably represents the ISDN user traffic for the SCAR network model and simulation. There are sufficient degrees of freedom to permit a number of tailored scenarios to determine the ISDN communications satellite design parameter limits, test subsystems and procedure and stress the overall system. An example of scenario profile for four cities: Baltimore, Chicago, Los Angeles, and San Francisco using the industries of broadcast, construction, communications, data processing, and education across all bearer services is shown in Figure 3.4, "Scenario Generation Example".

3.5 Scenario Scripts. Scenario scripts consists of descriptive text that presents the objectives, goals, strategy, and the selected scenario components that are to be used to generate a given scenario. These scenario scripts are used in conjunction with the ScenGen program and the traffic model database. Each scenario has a reason for being. They address a specific aspect of the NASA SCAR design for an advanced ISDN communications satellite. The ISDN satellite topology, design parameters, and environment are part of the simulation initial conditions for the subsequent scenario discrete events requesting and relinquishing ISDN bearer services.

3.5.1 Scenario Scripts Types. Four types of scenarios will be used in this NASA SCAR Program: checkout, baseline, stress, and special scenarios. A checkout scenario will be used to verify the functionality of various sets of ISDN subsystems of the satellite design. The objectives here are to quickly and easily demonstrate that the actions and protocols that accompany a specific ISDN bearer service are modeled and simulated properly and are operating as described in the standards. Five checkout scenarios are planned for this NASA SCAR Program: CS64, CS128, DX25, BFRAMERELY, and TELEMETRY. These checkout scenario address the bearer services that are identified in the traffic model database.

A baseline scenario will be developed and used as standard for all NASA SCAR Program simulations. The purpose is to provide a benchmark that will produce comparable results as the advanced ISDN communications satellite design evolves. This baseline scenario should include a sufficient variety of ISDN traffic to adequately gauge the satellite design.

Stress scenarios will be developed to determine the limits of the ISDN communications satellite design. The objective is to find the break points in the design in order to determine

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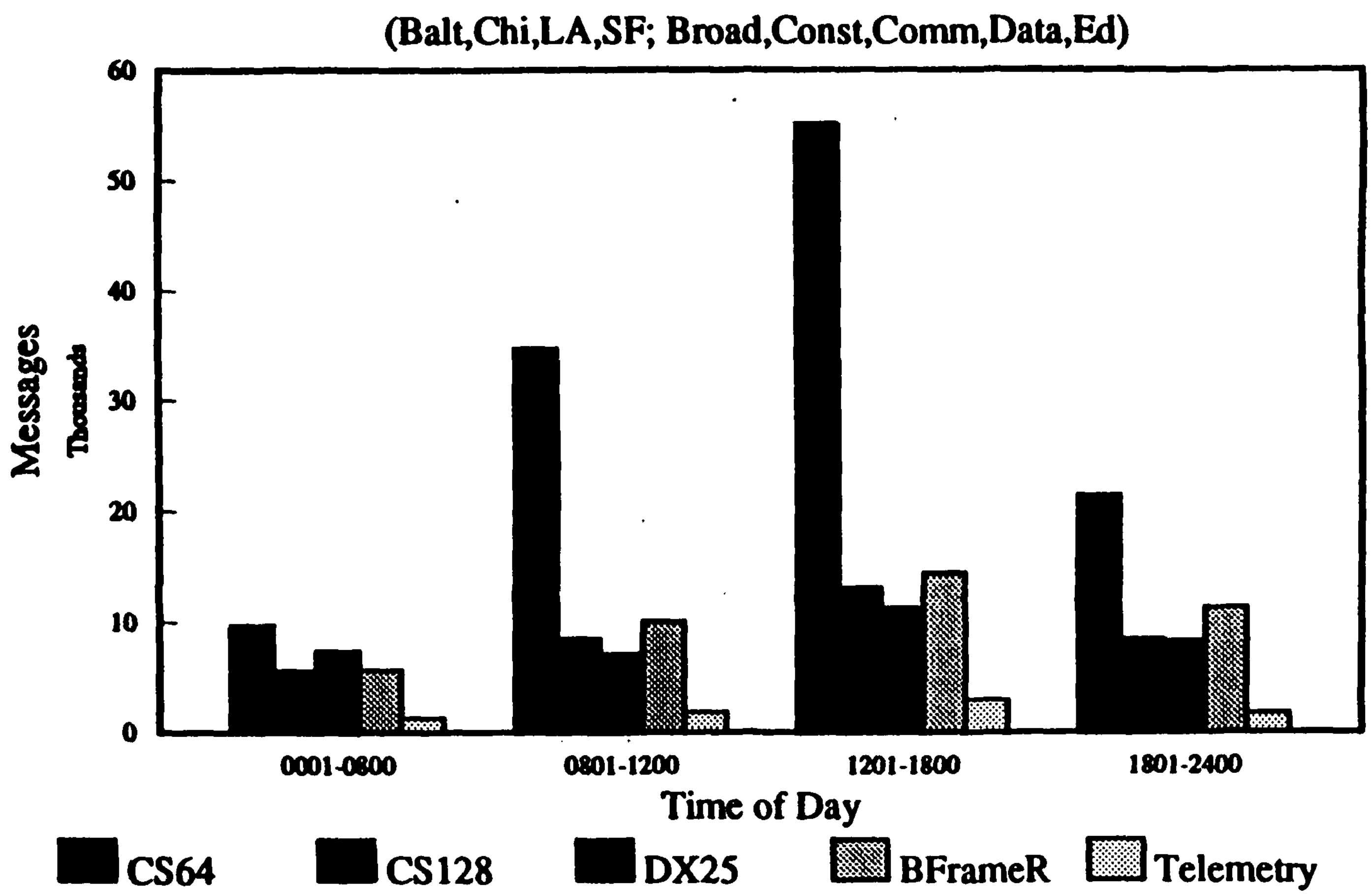

Figure 3.4 Scenario Generation Example

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Scen Gen Exam Profile
August 23, 1991

the engineering and operating envelop for the system. Three stress scenarios are planned: traffic stress, environment stress, and link breakdown stress. The traffic stress scenario will the message scale factor to systematically increase the traffic of an ISDN message distribution until a failure occurs. The environment stress scenario will systematically add weather losses to the system to determine the utility of weather mitigating techniques. The link-breakdown stress scenario will systematically disable single communication links to simulate a link-breakdown in order to determine the system robustness.

Special scenario will be developed on a demand basis to investigate specific attributes of the ISDN communications satellite design. At least one special scenario will be developed for this NASA SCAR Program.

3.5.2 Scenario Scripts Options. The rationale for a scenario script must include a list of traffic model database components that are to participate in the scenario. Figure 3.5, "Scenario Selection Options", shows the database architecture for the traffic model indicating the scenario selection options that are available. Once these options are selected, the ScenGen program automatically implements the algorithm presented in Section 3.4 to generate a STF for the ISDN network model simulation. By selecting combinations of cities, industries, applications, time-slots, and bearer services 204,120 ISDN message elements can be formed into any distribution of ISDN message traffic. A message scale factor is used to sculpture this ISDN message distribution to suit the traffic load desired.

The scenario selection process, as part of ScenGen, consists of:

- Selecting the cities
- Selecting the industries
- Selecting the applications
- Selecting the time-slots
- Selecting the bearer services
- Choosing a message factor.

Table 3.6, "Scenario Generation (ScenGen) Selection Process" summarizes the scenario structure for the scenario types that will be described below. Each column represents a specific scenario type identifying the selected cities, industries, applications, time-slots bearer services, and message scale factor.

3.5.3 Checkout Scenario Script. The five checkout scenarios consist of an exchange of ISDN traffic between an east coast city and a west coast city. Since these

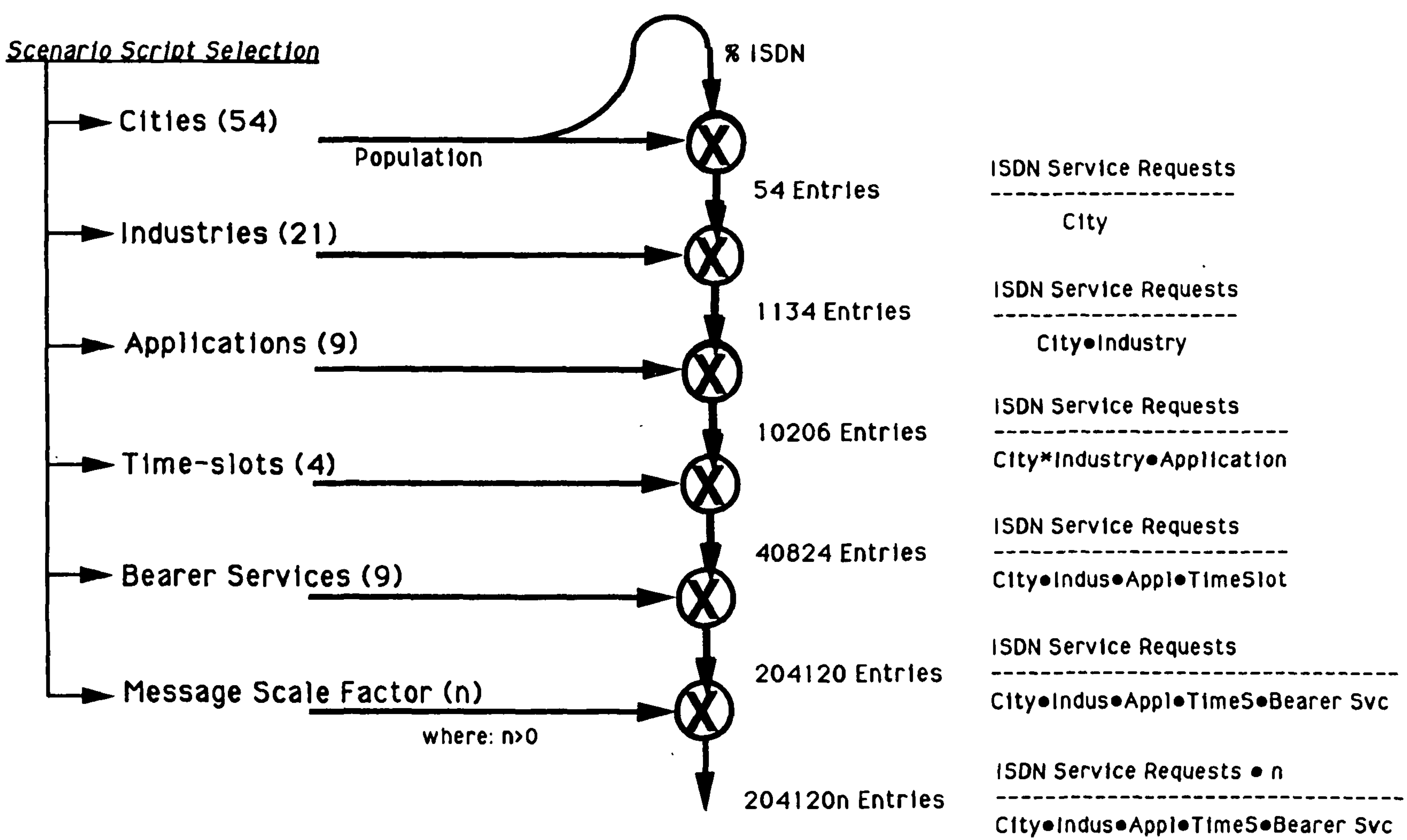

Figure 3.5 Scenario Script Selection Options

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SCen Script Selec Options
August 23, 1991

Table 3.6 Scenario Generation (ScenGen) Selection Process

Scenario Type:	Checkout CS64			Checkout CS128			Checkout DX25			Checkout BFRAMERELY			Checkout Telemetry			Baseline –			Stress Traffic		
		Population	%		Population	%		Population	%		Population	%		Population	%		Population (,000)	%		Population (,000)	%
Cities:	LA	13,770,000	0.045	San Fran	6,042,000	0.040	San Diego	2,370,000	0.033	Seattle	2,421,000	0.034	Denver	1,858,000	0.031	LA	13,770	0.045	LA	13,770	0.045
	Wash DC	3,734,000	0.033	New York	18,120,000	0.050	Boston	4,110,000	0.033	Baltimore	2,342,000	0.032	Miami	3,001,000	0.033	Wash DC	3,734	0.033	Wash DC	3,734	0.033
																San Fran	6,042	0.040	San Fran	6,042	0.040
																New York	18,120	0.050	New York	18,120	0.050
																San Diego	2,370	0.033	San Diego	2,370	0.033
																Boston	4,110	0.033	Boston	4,110	0.033
																Seattle	2,421	0.034	Seattle	2,421	0.034
																Baltimore	2,342	0.032	Baltimore	2,342	0.032
																Denver	1,858	0.031	Denver	1,858	0.031
																Miami	3,001	0.033	Miami	3,001	0.033
Resultant Msgs/day		742,872			1,147,680			213,840			157,258			156,631			2,418			2,418	
Industry:	Communication	74,287	0.100	Communications	114,768	0.100	Communications	21,384	0.100	Communications	15,726	0.100	Communicati	15,663	0.100	Communications	242	0.100	Communications	242	0.100
																Education	145	0.060	Education	145	0.060
																Financial	193	0.080	Financial	193	0.080
																Government	193	0.080	Government	193	0.080
																Manufacturing	145	0.060	Manufacturing	145	0.060
																Medical	145	0.060	Medical	145	0.060
																Military	242	0.100	Military	242	0.100
																Transport	145	0.060	Transport	145	0.060
																				0	
																	1,451			1,451	
Application:	Voice(Interactiv	4,457	0.060	Facsimile	11,477	0.100	Facsimile	2,138	0.100	File Transfer	1,730	0.110	Transaction	1,253	0.080	All	1,451	1.000	All	1,451	1.000
Time-slots:	All	4,457	1.000	All	11,477	1.000	All	2,138	1.000	All	1,730	1.000	All	1,253	1.000	All	1,451	1.000	All	1,451	1.000
Bearer Services:	CS64	4,457	1.000	CS128	1,722	0.150	DX25	43	0.020	BFRAMERELY	259	0.150	Telemetry	125	0.100	All	1,451	1.000	All	1,451	1.000
Msg Scale Factor	Unity	4,457	1.000	Unity	1,722	1.000	Unity	43	1.000	Unity	259	1.000	Unity	125	1.000	Unity	1,451	1.000	5x	7,255	5.000
		==========			==========			========			========			========			======			======	
	Messages/Day	4,457			1,722			43			259			125			1,451	,000		7,255	,000

scenarios are used to check out the operations of a particular ISDN bearer services, only that bearer service is selected. According to the traffic model database the communications industry is the greatest user of ISDN services, therefore, it was selected for all the checkout scenarios. A different application was selected for each checkout scenario to provide some degree of variety. All possible time-slots were selected and a unity message scale factor was used. The number of ISDN service requests and terminations varied from thousands to tens of initiating discrete event messages in line with the scenario selection process. Since all these scenarios are to be used primarily for ISDN subsystem functional verifications the message count is not as important as the protocol sequence that tasks the ISDN services.

3.5.4 Baseline Scenario Script. Again, as shown in Table 3.6, the baseline scenario used all the cities from all the checkout scenario generating 2.4 million potential ISDN service requests. This traffic is the sculptured by selecting the top eight ISDN user industries: communications, education, financial, government, manufacturing, medical, military, and transportation resulting in 1.4 million ISDN service requests. These ISDN service requests are distributed over all application, time-slots, and ISDN bearer services. A unity message scale factor is used.

This baseline scenario will be used a benchmark to evaluate the progress of the evolution and variations of the advanced ISDN communications satellite design.

3.5.5 Stress Scenario Script. The traffic stress scenario consists of the baseline scenario with a message scale factor of five. As shown in Table 3.6, over 7.2 million request for ISDN data services are presented to the ISDN network model simulation. If no break-down point is achieved with this stress scenario, the message scale factor will be increase until the weakest link in the ISDN network is exposed.

The link-loss scenario consists of using the baseline scenario and introducing specific communication link breakdowns as a function of time during the execution of the STF. This will permit a comparable evaluation between benign environment of the baseline scenario and the link-loss scenario.

Similarly the weather environment scenario will use the baseline scenario that includes variations of propagation parameters related to weather. The weather mitigating subsystem models should be automatically compensate for some level of weather interference

3.5.6 Special Scenario Script. The special scenario will be devised on a demand basis. A set of cities, industries, applications, time-slots, bearer services and message scale factor will be used to provide a special ISDN distribution of traffic.

For example, a Mother's Day scenario could have all cities using interactive voice on CS64 bearer service all day with a message scale factor corresponding the the known traffic volume.

Another example, a Sports Relay could have two cities using B-FRAMERELAY bearer service for a four hour period to provide that sport event coverage to other part of the country.

SECTION 4
PERFORMANCE MEASURES

4.1 Introduction. As shown in Figure 4.1, "Performance Measures - Introduction", the performance measure definitions effects all aspects of this SCAR program. Performance measures will be used to evaluate both the hardware and software for the advanced ISDN communications satellite design. As such these performance measure must be associated with observables that can quantified and impartially measured. In general these performance measures must be in line with CCITT standards especially as they pertain to satellite service in ISDN.

These performance measures must be integrated into both the scenario generations process to focus attention on what is to be measured and on the modeling and simulation software to ensure that the parameters necessary for these measures are included in the design. Using the user perspective, these performance standards are derived for communication links in end-to-end connections.

After a brief introduction, definitions and the purpose of performance measure will be addressed. Categories of performance measures will be identified and described. A summary of the performance measures methodology will be provided.

4.2 Definition and Purpose. Performance measures must identify with those elements of the system that are critical to the system performance. They must also provide a quantitative unit of measure for these element performance. The development of these performance measures forces a systematic approach to the technical definitions of the system modeling/simulation objectives. They provide the basis for the design for the system simulations and lead to the documentation of the technical objectives of the system model and simulation.

4.3 Performance Measures Categories. We have identified four categories of performance measures for the SCAR advanced ISDN communications satellite system: throughput, response time, blocking probability, and robustness. Each is discussed in turn.

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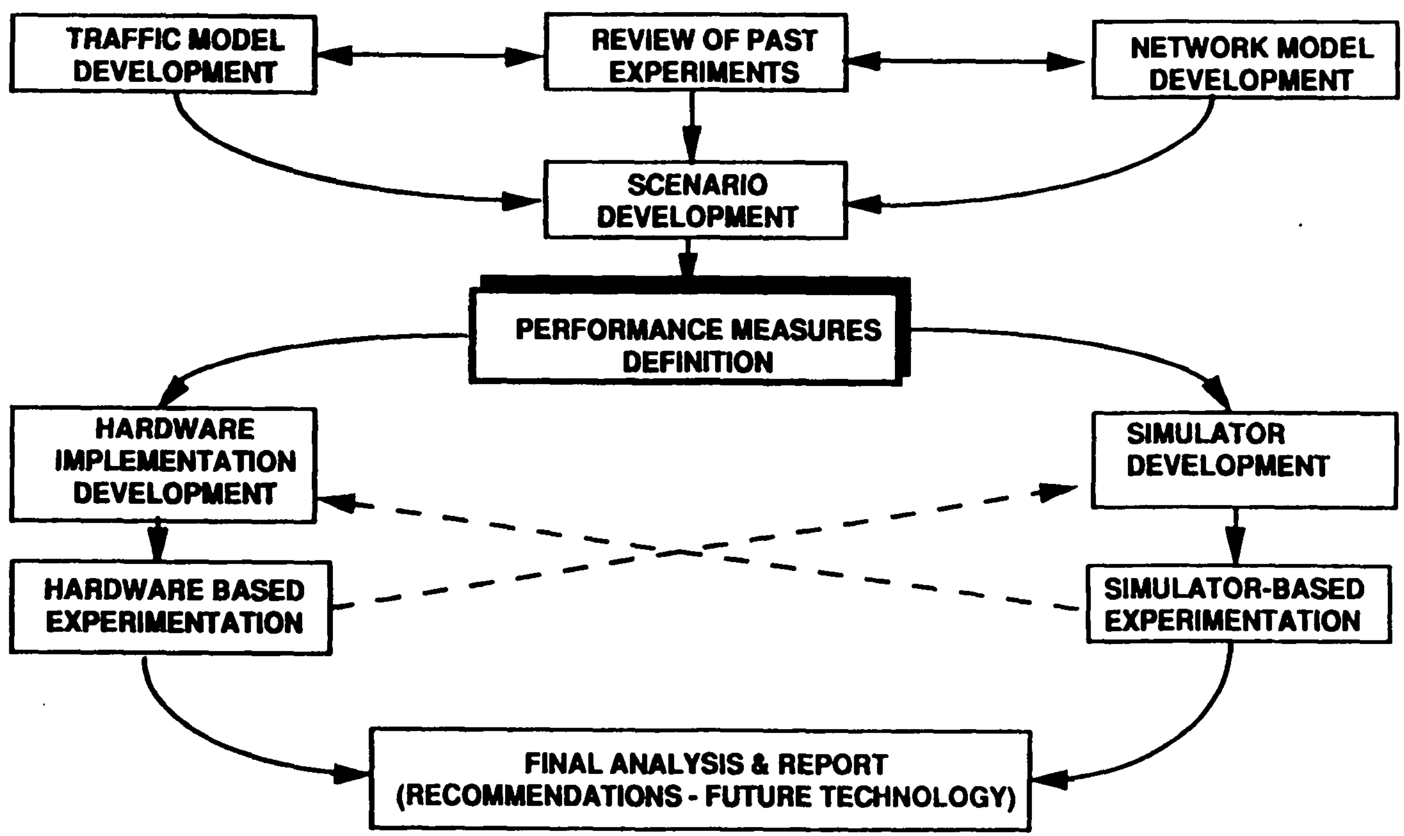

Figure 4.1 Performance Measures - Introduction

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4.3.1 Throughput. Throughput refers to the communications capacity to transfer a quantifiable amount of communications traffic, see Figure 4.2, "Performance Measure - Throughput". It can be quantified in several unit of measure: bits per seconds, messages per seconds, frame pers seconds, number of simultaneous channels, etc.

A number of ISDN communications satellite design factors contribute to the communications throughput. The intrinsic ISDN channel capacity of the B-Channel and D-Channel and their bundling into a T1 structure form a natural restriction on throughput. The satellite connectivity further constrains this potential ISDN throughput. Satellite antenna gains, beam widths, and dwell capabilities mitigate the communications capacity. The uplink/downlink accesses using TDMA slots, FDMA frequencies, and CDMA codes restrict the number of ISDN channels that can be serviced. In term of protocol and traffic queuing the buffer sizes and the processor speeds meaningfully affect the throughput.

Throughput evaluations apply at all level of communications and therefore affect all major modeling and simulation modules. Since in a satellite environment the traffic shares many of the communication links with the control protocol, both traffic and protocol throughput must be considered in the analysis of throughput.

The throughput performance measure will be the number of B-Channels that be simultaneously supported or the bits per second of uplink and downlink capacity.

4.3.2 Response Time. Response time refers to the speed at which a system can supply throughput, see Figure 4.3, "Performance Measure - Response Time". It can be quantified in the time required to set up a circuit, the time from the sending to the receipt of a packet, the time from keyboard selection to screen response, etc.

Response time in a satellite communications system is principally limited by the propagation delays between the ground stations and the satellite. Processing time delays contribute in proportion to software that must be executed to support communications. In an ISDN software intensive system this means that much attention must be given to software execution times. The satellite antenna reaction and revisit times add linearly to the response time. The time it takes for an uplink access is limited by framing time and contention resolution time of the modulation scheme and the contention algorithm. Response time is also extended by the time-outs within the ISDN and SS7 protocols, and by the coding delays that accompany error detection and error corrections.

THROUGHPUT REFERS TO THE COMMUNICATIONS CAPACITY TO TRANSFER A QUANTIFIABLE AMOUNT OF COMMUNICATIONS TRAFFIC. CAN BE QUANTIFIED IN SEVERAL UNITS OF MEASURE: MESSAGES PER SECOND, BITS PER SECOND, FRAMES PER SECOND, SIMULTANEOUS CHANNELS, ETC.

FACTORS

RESOURCE ALLOCATION

- CHANNEL (MEGABITS OR CHANNELS)
  - D CHANNEL CAPACITY
  - B CHANNEL CAPACITY
- ANTENNAS (HIGH GAIN, POINTING,...)
- TDMA SLOTS
- FDMA FREQUENCIES
- CDMA CODES (CAPACITY)
- BUFFER STACKS (FOR BEARER CHANNELS)

APPLICATION LEVEL

TO THE MAJOR SUBSYSTEM LEVEL FOR RESOURCES.

TO THE LOGIC DECISION LEVEL FOR PROTOCOLS

Figure 4.2 Performance Measure - Throughput

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RESPONSE TIME REFERS TO THE SPEED AT WHICH A SYSTEM CAN SUPPLY THROUGHPUT. CAN BE QUANTIFIED IN TIME REQUIRED TO SET UP THE CIRCUIT, TIME FROM SEND TO RECEIPT OF A PACKET, ETC.

FACTORS

PROPAGATION TIME (FUNCTION OF SATELLITE & USER POSITION)

PROCESSING TIME (COMPUTER)

PHYSICAL REACTION TIME (ANTENNA POSITIONING)

FRAMING TIME (MULTIPLEX SLOTTING, BUFFERING, ETC)

CONTENTION RESOLUTION TIME (CONTENTION FOR RESOURCES)

TIME OUTS (DELAYS RESULTING IN BLOCKED CALL)

CODING DELAYS (INTERLEAVING DEPTH, BLICK CODE LENGTHS, ETC)

APPLICATION LEVEL

1ST SUBSYSTEM FOR ALL PHYSICAL ELEMENTS.

TO THE DECISION LOGIC LEVEL FOR PROTOCOLS FOR THE OBP

Figure 4.3 Performance Measure - Response Time

Though the response time is principally involved with the set up time of an ISDN communications channel it permeates every communication subsystem and every model and simulations module. Every stage of protocol processing and traffic moving takes time that can be accumulated into response time. The response times at all first level interfaces are most visible but the response times associated with decision logic depth for ISDN and SS7 protocol processing in the on-board processor (OBP) could be of comparable magnitude.

The measure of response time will be the time it takes set up an ISDN service from the time it was requested.

4.3.3 Blocking Probability. Blocking probability refers to the likelihood that a given call request can not be satisfied, see Figure 4.4, "Performance Measure - Blocking Probability". It is quantified by a probability number between zero and unity. The objective is to seek the lowest blocking probability for a given design.

The factors that contribute to the communications blocking probability generally deal with limits on available resources: channels, buffers, or time. Though the capacity of the D-Channel for control could limit the assignment of the bearer service B-Channels, the ISDN architecture has generally provide sufficient control channel margin. In an ISDN communications satellite architecture, however, the number of B-channel resources that can be allocated is more limited than in the terrestrial environment. The denial of uplink access is not generally considered part of the blocking probability. It acts like the line-finder access to telephone exchanges and is more associate with availability. But in advanced ISDN communications satellites where the OBPs control the assignment of the bearer services, B-Channels, and the downlink transmission paths, call blocking can occur when any of these resources are unavailable.

From an application point of view the blocking probability is associated with the ability of the OBP to assign the resources to complete an ISDN service. At that decision point the OBP logs the request for ISDN service as being blocked, and takes the appropriate steps to inform the requesting party. A more general view of blocking probability would include denial of uplink access and unavailability of intermediate buffers, but there are no mechanisms in the real world for accumulating these statistics or informing the party being blocked.

BLOCKING PROBABILITY REFERS TO THE LIKLIHOOD THAT A GIVEN CALL REQUEST WILL NOT BE SATISFIED. CAN BE QUANTIFIED BY THE PROBABILITY ON NON-BLOCKING IN A RANGE OF .000 TO 1.000.

FACTORS

CONTROL CHANNEL CAPACITY

BEARER CHANNEL CAPACITY

PROCESSING CAPACITY
- BUFFERS

TRANSMISSION CHANNEL RESOURCES

APPLICATION LEVEL

2ND & 3RD LEVEL PROTOCOL PROCESSES

ON BOARD PROCESSING

Figure 4.4 Performance Measure - Blocking Probability

The measure of blocking probability will be the number or percentage of ISDN service requests that are denied by the OPB due to the lack of resources.

4.3.4 Robustness. Robustness refers to ability of the system to recover from any finite state transitions, see Figure 4.5, "Performance Measure - Robustness".
A number of factors can be associated with robustness. Robustness must counter many forms of inadvertent events and states. Each of these undesirable events and states must rectified but unique singular solutions. To recover from an undesired logic state the solution relies on prevention software to avoid that logic state or special time-out or correction software to exit the undesired logic state. Buffer or stack overflows must correctable on the spot, in real-time, and with minimal information loss. Locked up capacity on the B-Channels and D-Channels must be resolved by early detection and the selective shedding of load. The protocol must capable of positive recovery from any loss of response usually after some time-out period. Erroneous routing must resolved by default options or centralized review by the OBP for action.

Though most effects of robustness can be resolved by the OBP many unpredictable actions or operations will require reviewing and redressing to recover from undesirable events or states.

The measure of robustness will be the number ISDN communications anomalies that occur after the network model and simulation has been checked out and debugged for the advanced ISDN communications satellite.

4.4 Performance Measures Summary. The selection of these performance measures is essential for the success of this research. Their integration into the design, model, and simulation of an advanced ISDN communications satellite is shown in Table 4.1, "NASA SCAR Performance Measures Matrix".

As such these performance measures determine the complexity of the design, model, simulation and analysis associated with the NASA SCAR Program. Therefore, these performance measures must be prioritized as to the relative importance to allow some flexibility in controlling scope of the NASA SCAR effort.

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PROTOCOL ROBUSTNESS REFERS TO THE RELIABILITY OF THE SYSTEM TO RECOVER FROM ANY FALSE FINITE STATE TRANSITION.

FACTORS

- LOGIC (LOGIC DECISION POINTS)
- INSUFFICIENT CAPACITY (BUFFERING AND STACKING OF PROTOCOL MESSAGES)
- LOCKED UP THROUGHPUT CAPACITY (BEARER CHANNELS)
- LOCKED UP CONTROL CAPACITY (D CHANNELS)
- LOST RESPONSES
- ERRONEOUS ROUTING (ERRORS IN ROUTING TABLES)

APPLICATION LEVELS

- 2ND AND 3RD LEVEL PROTOCOL
- ON BOARD PROCESSORS

Figure 4.5 Performance Measure - Robustness

Table 4.1 NASA SCAR Performance Measures Matrix

	Throughput	Response Time	Blocking Probability	Robustness
Satellite Antenna	Gain Beamwidth Dwell	Reaction Time Revisit Time		Gain
Uplink	TDMA Slots FDMA Frequency	Propagation Time Framing Time Contention Time	Contention Blocks	Receiver Sensitivity Weather
Downlink	FDMA Frequency Transmitter Power	Propagation Time	Transmission Channels	Weather
Modulation	CDMA Codes	Coding Delays		Coding Lockup
Processor	Buffer Size Stack Size	Processing Time Buffering Time Logic Depth		Logic hangup Buffer overflow Stack overflow Erroneous routing
ISDN	# of D-Channel # of B-Channel	Protocol Timeouts	D-Channel Capacity # of B-Channel Protocol Blocks	D-Channel Lockup B-Channel Lockup Protocol Races
Measures:	Bits per second Msgs per second Frames per second # simultaneous channels	subsystem delay seconds end-to-end delay seconds setup seconds	# of Svcs Denied % of Svcs Denied	# of anomalies type of anomolies

SECTION 5
SUMMARY

5.1 **General.** This update report presented the views of the scenario generation process and the performance measurement methodology. The process and methodology are applicable to the the Interim Service ISDN Satellite (ISIS) and the Full Service ISDN Satellite (FSIS). The ultimate aim of this aspect of the SCAR Program is the design of a new advanced ISDN communications satellite. The technical and operational parameters for this ISDN advanced communications satellite design will be obtained from an engineering software model of the major subsystems of the ISDN communications satellite architecture. Discrete event simulation experiments will be performed with the model using various traffic scenarios, technical parameters, and operational procedures. These data from those simulations will be analyzed using the performance measures discussed in this report.

5.2 **Review.** After an introduction that provided the background and scope of this NASA SCAR Program, the use of modeling and simulation to determine the parameters for the advanced ISDN communications satellite design was presented. An overview of the modeling and simulation tasks included a brief description of the four software programs for the effort. Particular associations were made between the the Scenario Generation Program and the Scenarios described herein, and the Product Generation Program and the Performance Measures just discussed. The two main sections of this update report are Scenario Generation and Performance Measures.

The Scenario Generation Section described the Scenario Generation Program and its association with the Traffic Model Database. After a brief description of the traffic model database elements, they were used in a scenario generation example demonstrating their flexibility and utility in generating a STF. Four types Scenario Scripts were defined: checkout, baseline, stress, and special scenarios. Each were described in detail together with their utility to the SCAR advanced ISDN communications satellite design process

The Performance Measures Section introduced the concepts, definitions, and purposes of these measures. Four performance measure categories were identified: throughput, response time, blocking probability, and robustness. Each was presented in detail identifying their major factors, their application levels, and their measures for the NASA

SCAR effort. A summary matrix was generated associating the performance measures with the major subsystems of the modeling and simulation effort.

5.3 Results. The research and results in both the scenario generation and the performance measures areas are adequate to support the other tasks of this NASA SCAR Program. Only minor refinement will be needed to integrate these scenarios and performance measures with the traffic model and network model simulation of the NASA SCAR advanced ISDN communications satellite.

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15. Supplementary Notes

16. Abstract

The Scenarios and Performance Measures Update Status Report for Advanced Satellite Designs and Experiments describes contemplated input and expected output for the Interim Service ISDN Satellite (ISIS) and Full Service ISDN Satellite (FSIS) Models. The discrete event simulations of these models will be presented with specific scenarios that will exercise and stress its ISDN satellite parameters. Performance measure criteria are presented for evaluating the advanced ISDN communication satellite designs of the NASA Satellite Communications Research (SCAR) Program.

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